Midterm experience with the endovascular treatment of isolated iliac aneurysms

Luis A. Sanchez, MD, Amit V. Patel, MD, Takao Ohki, MD, William D. Suggs, MD, Reese A. Wain, MD, Jennifer Valladares, PA, Jacob Cynamon, MD, John Rigg, BS, and **Frank J. Veith, MD,** *New York, NY, and Morristown, NJ*

Purpose: **This report describes our 5-year experience with the endovascular repair of isolated iliac aneurysms and pseudoaneurysms.**

Methods: **Between June 1993 and July 1998, 40 isolated iliac aneurysms and pseudoaneurysms were treated with endovascular grafts in 39 patients. Thirty-seven aneurysms were treated with endovascular grafts composed of polytetrafluoroethylene grafts and balloon expandable stents, and the other three underwent repair with a polycarbonate urethane endoluminal graft.**

Results: **All the patients underwent initially successful endovascular treatment of isolated iliac aneurysms and pseudoaneurysms and were followed from 1 to 51 months (mean, 18 months). The 4-year primary patency rate was 94.5% ± 10%. The perioperative complications included one episode of distal embolization, an episode of colonic ischemia, five episodes of kinking or compression of the endovascular graft, and one early postoperative graft thrombosis. There was only one perioperative death in a patient whose aneurysm ruptured in the operating room just before endovascular repair. The median postoperative length of hospital stay was 3.0 ± 1.3 days in this group of patients at moderate and high risk. The long-term complications included one graft thrombosis and two endoleaks. One small endoleak was followed until the patient died of unrelated causes, and the other one led to aneurysm rupture in the only patient temporarily lost to follow-up examination. This patient successfully underwent treatment in the standard open surgical fashion. To date, all the other aneurysms have remained stable or have decreased in size during the follow-up examinations with duplex or contrast-enhanced computed tomographic scans.**

Conclusion: **Endovascular repair of iliac aneurysms and pseudoaneurysms is a safe and effective technique with good midterm results in patients at standard and high risk. These grafts are particularly beneficial for patients with medical, surgical, or anatomic contraindications for open surgical repair. (J Vasc Surg 1999;30:907-14.)**

From the Divisions of Vascular Surgery and Interventional Radiology (Dr Cynamon), Montefiore Medical Center/ Albert Einstein College of Medicine, and the Surgical Specialists of New Jersey (Dr Patel), Morristown Memorial Hospital.

Supported by grants from the US Health Service (HL02990-03), the James Hilton Manning and Emma Austin Manning Foundation, The Anna S. Brown Trust, and the New York Institute for Vascular Studies.

Presented at the Twenty-fifth Annual Meeting of the New England Society for Vascular Surgery, Toronto, Ontario, Canada, Sep 24–25, 1998.

Reprint requests: Dr Luis A. Sanchez, Division of Vascular Surgery, Barnes-Jewish Medical Center, No. 1 Barnes Hospital Plaza, Ste 5103, St Louis, MO 63110.

0741-5214/99/$8.00 + 0 **24/6/101466**

Isolated iliac artery aneurysms are relatively uncommon, with an incidence rate as low as 0.03% in a large autopsy series.[1] In clinical series, these aneurysms account for 2% to 7% of atherosclerotic aneurysms of the aortoiliac segment.[2-6] These aneurysms are multiple in as many as 67% of the patients as reported by Richardson and Greenfield[4] and are often asymptomatic. About half of patients have symptoms that include rupture, embolization, thrombosis, and pressure symptoms, much like symptomatic abdominal aortic aneurysms. Difficulty in the detection of these aneurysms as a result of their location and the technical difficulties associated with the repair of these pelvic arterial lesions, particularly in patients with a history of previous aortic surgery, make treatment a continuing challenge. The

mortality rates after rupture and emergent surgery for the repair of these aneurysms are as high as 33%,[4] and the mortality rates after elective repair have been slightly worse than after abdominal aneurysm repair, averaging around 10% (range, 0 to 50%) in published series.[2-6] The treatment results continue to improve, as reported recently by Krupski et al[7] who experienced no perioperative mortalities in a group of 19 patients at good risk. Interestingly, these investigators treated their two patients who were at high risk with endovascular techniques.[7]

Iliac artery pseudoaneurysms are caused by previous surgery, trauma, or other intravascular medical interventions. Anastomotic pseudoaneurysms are relatively uncommon, with an observed incidence rate of 0.2% to 15% in different series.[8-10] Other pseudoaneurysms that are the result of trauma or medical interventions are even less common. Untreated pseudoaneurysms are prone to the same complications as are true aneurysms, with operative mortality rates of 8% to 19% in elective cases of anastomotic pseudoaneurysm repair.[11,12] The associated mortality rates after emergency surgery are even higher.[11,12] The high morbidity and mortality rates are caused by technical difficulties associated with secondary intra-abdominal or retroperitoneal vascular operations, obliteration of normal tissue planes by the pseudoaneurysm, and the aging of the general population. Morever, many of these life-threatening aneurysms and pseudoaneurysms exist in patients with multiple comorbid medical conditions that make standard open surgical repair risky.

Alternative therapies with simple aneurysm ligation, coil embolization, or the placement of porous intravascular stents have been used in an attempt to treat these isolated iliac aneurysms.[7,13-14] Although radiographic exclusion has been shown with these techniques, continued growth and rupture of the aneurysms have been repeatedly documented.[7,15-18] Endovascular grafts, which were initially used for the treatment of inoperable aortic aneurysms, are the most recent alternative for the treatment of iliac aneurysms and other arterial lesions. This form of less invasive treatment holds the promise of decreased perioperative morbidity and mortality rates.[19-22] This report describes our 5-year experience with the use of endovascular grafts for the treatment of 40 isolated iliac aneurysms and pseudoaneurysms with follow-up periods as long as 51 months.

PATIENTS AND METHODS

Patients. Thirty-nine patients (36 men, three women) with a total of 40 isolated iliac aneurysms or pseudoaneurysms (32 true aneurysms and eight pseudoaneurysms) underwent treatment at Montefiore Medical Center (n = 30) and Morristown Memorial Hospital (n = 10) between August 1993 and August 1998. The mean age of the patients was 68 years (range, 56 to 88 years). All the patients had at least one significant comorbid medical condition that increased the risk for standard surgical repair as suggested by the Society for Vascular Surgery/International Society for Cardiovascular Surgery Ad Hoc Committee on Reporting Standards.[23] These comorbid conditions included: moderate or severe coronary artery disease in 63% of the patients, moderate or severe hypertension in 38% of the patients, moderate or severe chronic obstructive pulmonary disease in 25% of the patients, severe chronic renal insufficiency in 10% of the patients, and previous aortoiliac surgery or major intra-abdominal or retroperitoneal procedures in 25% of the patients.

The 40 iliac aneurysms and pseudoaneurysms that were treated included: 28 common iliac aneurysms, four internal iliac aneurysms, four common iliac pseudoaneurysms, and four external iliac pseudoaneurysms. The aneurysms ranged in diameter from 2.5 to 11 cm (mean, 5.2 cm). No aneurysm showed evidence of free rupture at the time of the preoperative computed tomographic (CT) scan and arteriogram. The patients were followed from 1 to 51 months, with a mean follow-up period of 18 months. Only one patient was temporarily lost to follow-up examination after the first postoperative visit and was seen, 18 months after the endovascular repair, with a rupture of the previously treated iliac aneurysm.

Endovascular graft devices. Most isolated iliac aneurysms and pseudoaneurysms (n = 37) were excluded with a transluminally placed endovascular graft (TPEG).[19-21] All the TPEGs used in this study were constructed with 6-mm polytetrafluoroethylene grafts (W.L. Gore and Associates, Flagstaff, Ariz; and Impra, Inc, Tempe, Ariz). Each graft was sutured to a Palmaz balloon expandable stent (Johnson & Johnson Interventional Systems, Warren, NJ), with 50% to 100% of the stent covered by the overlying graft. The ends of the graft were marked with 0.010-in radiopaque gold wire for precise proximal deployment of the endovascular graft and exact placement of a second distal stent across the end of the graft when it ended within the external iliac arteries. Alternatively, the distal end of the graft was cut to the appropriate length and sutured within the ipsilateral common femoral artery, which created an endovascular anastomosis. The endovascular graft was coaxially mounted on an appropriate-

ly sized angioplasty balloon and packaged within an introducer sheath that ranged from 14F to 20F in diameter.

Three patients underwent repair of external iliac artery pseudoaneurysms with the Corvita endoluminal graft (Corvita Corporation, Miami, Fla). This endovascular graft consists of a tubular self-expanding multiwire braid made from Phynox (Elgiloy, Corvita Corporation) wire lined with a porous polycarbonate urethane (Corethane, Corvita Corporation) elastomer. The corethane structure is made from many layers of spun fibers bonded to each other to form a well-controlled, non-woven structure. The corethane liner is integrally bonded to the braided wire structure by means of an interpenetrating network of fibers that traverse the interstices of the braid. The 9F Balt introducer system (Corvita Corporation) was used for the deployment of this endovascular graft.

The use of all the endovascular grafts was approved by the respective institutional review boards. The TPEGs were used under a physician-sponsored investigational device exemption, and the Corvita endoluminal grafts were part of a Food and Drug Administration–approved multicenter study.

Diagnostic evaluation and hypogastric artery embolization. All the patients underwent preoperative arteriography and contrast-enhanced CT scanning to define the morphologic characteristics of the aneurysm to be treated, including precise diameter and length measurements. The size and anatomic location of the aneurysm, the length of the aneurysm neck proximally and distally, and the associated aortoiliac anatomy were used to plan the endovascular repair. Various combinations are possible to exclude iliac aneurysms with endovascular grafts. These have been described in detail in our initial publication on this topic in 1995.[19] These include the following combinations: ilioiliac or iliofemoral endovascular grafts for iliac aneurysms with a good proximal neck or hypogastric aneurysms, and aortoiliac or aortofemoral endovascular grafts with a contralateral occluding stent and a femorofemoral bypass graft for patients without a proximal iliac neck or additional aortoiliac disease.

Ipsilateral hypogastric artery embolization with appropriately sized embolization coils (Gianturco coils or Hilal embolization microcoils, Cook, Inc, Bloomington, Ind) was performed in patients with a patent ipsilateral hypogastric artery in whom the planned endovascular graft was to extend across its orifice and end in the external iliac or femoral arteries. The coils were placed in the proximal portion of the hypogastric artery, maintaining communication between its anterior and posterior divisions. Patients with hypogastric artery aneurysms underwent distal coil embolization of the anterior and posterior divisions to prevent retrograde flow into the aneurysm sac after endovascular graft exclusion of the origin of the hypogastric artery. The embolizations were performed at the time of preoperative diagnostic arteriography or in the operating room just before endovascular graft deployment.

Endovascular graft deployment technique. All the procedures were performed in the operating room, and the devices were introduced into the arterial system through an open femoral arteriotomy. The devices, within their introducer sheaths, were coaxially advanced to the planned deployment site with fluoroscopic control. After retracting the introducer sheath, the proximal stent was deployed with the balloon catheter and the remaining graft was exposed with retraction of the introducer sheath. The graft was sequentially dilated to mold it to the arterial surface, unfolding all wrinkles and kinks. If the planned endpoint for the graft was in the external iliac artery, a second stent was deployed across the end of the graft visualized fluoroscopically with the gold marker. Otherwise, the graft was brought out through the femoral arteriotomy, cut to the proper length, and an endoluminal anastomosis performed.[25] With the later technique, the length of the graft was not an issue and any disease in the external iliac artery was covered by the endovascular graft.

The Corvita endoluminal graft was only used for patients with external iliac artery pseudoaneurysms.[26] This device is fully supported and can be cut to length. The diameter of the involved artery proximally and distally was carefully assessed as was the length of the lesion. The grafts were oversized by 1 to 2 mm and cut to the necessary length. The graft was then backloaded into the sheath (9F for 8-mm, 10-mm, and 12-mm diameter grafts) and introduced over a guidewire with fluoroscopic control. The grafts were deployed by holding them in place with a pusher rod and retracting the introducer sheath to allow self expansion of the endovascular graft.

Follow-up evaluations. A completion intraoperative arteriogram was performed in every case to ensure complete aneurysm exclusion. A color flow duplex scan was performed before discharge with every patient, and a contrast-enhanced CT scan was performed within the first postoperative month. All the patients underwent serial contrast-enhanced CT scan at 6-month intervals if the previous study showed no leaks and a stable or shrinking aneurysm. The studies were repeated more fre-

quently if there was any question of an endoleak, an enlarging aneurysm, or symptoms referable to the lesion treated.

Statistics. The cumulative primary patency rates were calculated with the life-table method. The results were reported in accordance with the guidelines established by the Ad Hoc Committee on Reporting Standards, Society for Vascular Surgery/International Society for Cardiovascular Surgery, North American Chapter.[27]

RESULTS

All the patients underwent initially successful endovascular treatment of their isolated iliac aneurysms and pseudoaneurysms. Before endovascular graft placement, 32 patients underwent ipsilateral hypogastric artery coil embolization to prevent retrograde flow into the aneurysm sac after endovascular aneurysm exclusion. The four patients who underwent treatment for internal iliac artery aneurysms underwent successful embolization of the distal branches of the aneurysm, and the 28 patients with common iliac artery aneurysms and pseudoaneurysms underwent proximal hypogastric artery embolization. The remaining eight patients had chronically occluded ipsilateral internal iliac arteries (n = 5) or had isolated external iliac artery lesions (n = 3), and the graft was placed distal to the internal iliac artery origin.

The configuration of the endovascular graft used was made on the basis of the unique anatomy of each patient. Most aneurysms and pseudoaneurysms (98%) had a good proximal neck within the iliac arteries or the ipsilateral limb of a prior aortobiiliac graft, allowing a unilateral in-line exclusion of the aneurysmal lesions. The distal graft ended within the external iliac artery if the vessel was straight and healthy (18 grafts; 46%) or at the common femoral artery with an endoluminal anastomosis if the external iliac artery was diseased (22 grafts; 54%). One patient required an aortoiliac endovascular reconstruction with a femorofemoral bypass graft and contralateral iliac occlusion to exclude a large common iliac artery anastomotic aneurysm without a well-defined proximal neck.

All the procedures were performed in an operating room that was fully outfitted for endovascular procedures. On the basis of the overall condition of the patients at the time of the procedure, either general (n = 7), epidural (n = 28), or local (n = 5) anesthesia was used. The median operating time for these endovascular procedures was 4.5 hours, which reflects our continuing learning curve (range, 2.5 to 8.0 hours). The average amount of full strength contrast used during the procedure was 180 mL, with a range of 90 to 410 mLs. The fluoroscopy time ranged from 18 to 62 minutes, with a mean of 32 minutes. All the patients were followed from 1 to 51 months (mean, 18 months). The 4-year cumulative primary patency rate in this group of patients was 94.5% ± 10%, with a major complication rate of 7.5%, a minor complication rate of 15%, and a perioperative mortality rate of 2.5%.

The perioperative major complications (within 30 days) included one episode of distal embolization that required a distal bypass graft 2 months later, an episode of colonic ischemia that resolved with antibiotic therapy and bowel rest, and an episode of graft thrombosis 3 weeks after endovascular graft placement that required no further treatment because the patient remained asymptomatic. The minor perioperative complications included five episodes of kinking or compression of the endovascular graft that required additional placement of stents within the graft and one local groin hematoma that required no further treatment.

There was only one perioperative death in this series. A patient scheduled for elective repair of a 9-cm common iliac aneurysm had a hypotensive episode in the operating room as the procedure was started. The patient was immediately resuscitated, and an intraoperative arteriogram revealed a retroperitoneal rupture of the large iliac aneurysm. The endovascular repair was completed expeditiously, but unfortunately the patient died of postoperative cardiac complications despite a successful endovascular repair.

The late complications (after 30 days) included two endoleaks and one graft thrombosis 2 months after endovascular graft placement. The latter complication was treated with an aortofemoral bypass grafting procedure. One small proximal endoleak was present until the patient's death 18 months after graft implantation without enlargement of the aneurysm. The other endoleak occurred in the only patient who was temporarily lost to follow-up examination, and this patient was seen 18 months after the endovascular reconstruction with a contained, ruptured aneurysm that was successfully repaired in standard open surgical fashion. In addition, two patients underwent major amputations during the follow-up period. These were the results of infrainguinal disease and were unrelated to the endovascular graft. Both patients had undergone additional infrainguinal arterial reconstructions, which failed at 8 and 10 months and led to limb loss. The endovascular grafts that served as inflow to the failed infrain-

guinal reconstructions in these two patients remained patent without any hemodynamic lesions until the death of the patients from unrelated medical conditions. To date, all the other aneurysms have remained stable or have decreased in size on the basis of comparative measurements from the preoperative and postoperative contrast-enhanced CT scan results and no secondary or late endoleaks have been encountered. In this group of patients at moderate and high risk, the median postoperative length of hospital stay was 3.0 ± 1.3 days.

DISCUSSION

Isolated iliac aneurysms and pseudoaneurysms are often asymptomatic, but their natural history may be associated with significant morbidity and mortality. Difficulty in the detection of these lesions, technical concerns associated with their repair in patients with difficult anatomy and previous aortoiliac surgery, and significant comorbid medical conditions make treatment of these conditions a continuing challenge. Endovascular grafts have been used for the treatment of iliac aneurysms and pseudoaneurysms with early encouraging success.[19-22,24-26] Further improvements have been made with better patient selection, procedural enhancements, and device developments that could lead to a safer and more efficacious application of this rapidly evolving technique.

Our 5-year experience reflects the evolution of this surgical procedure. The 4-year patency rate of 95% compares favorably with published series of open surgical treatment of iliac aneurysms.[3-6] In addition, these encouraging midterm results were associated with low morbidity and mortality rates. Most postoperative complications were caused by technical aspects of the procedure that have improved with our growing experience. The episode of distal embolization was the result of manipulations within a diseased aorta. As technical expertise has increased and the profile of the introducer system has decreased, intra-arterial manipulations have decreased and become safer, making this complication less likely. Five patients required further intragraft stents to correct areas of kinking and extrinsic compression. These were necessary in patients with tortuous, calcified, or diseased iliac arteries because our TPEG device is not fully supported. Newer devices, like the Corvita Endoluminal Graft, the Wallgraft (Schneider, Inc, Minneapolis, Minn), the Passager graft (Boston Scientific Vascular, BSC, Wayne NJ), and the Hemobahn device (W.L. Gore and Associates), are fully supported and may not need further intragraft support if their radial strength is sufficient. On the other hand, the need to support some of our TPEGs to avoid kinking and narrowing is a reasonable trade off to maintain the versatility of our device, which is unequaled by any commercially made endovascular graft. Our system has the advantages of being applicable to patients with any combination of sizes of proximal and distal necks. In addition, it is useful to treat disease that extends to the femoral arteries, and there is no need to know the exact length of graft required because the graft is trimmed to the proper length and sutured within the common femoral artery.

Another important complication encountered was colonic ischemia that resolved with nonoperative therapy. The endovascular treatment of many iliac aneurysms and pseudoaneurysms requires occlusion of the ipsilateral hypogastric artery that could have contributed to bowel viability. However, this was not the case because the hypogastric embolizations carried out in this series led only to a single transient episode of colonic ischemia that may have been in part the result of intraoperative hypotension. These results are comparable with series of standard open surgical repair of aortoiliac aneurysms. Ipsilateral hypogastric artery occlusion was most commonly associated with postoperative buttock claudication. These symptoms occur in 10% to 30% of cases (nine of 32 patients in this series), improve over time, and can be limited by proximal hypogastric artery embolization that preserves the rich pelvic collateral network.

Only two patients had graft thrombosis develop in this series. Both the endovascular grafts failed because of technical issues at the proximal attachment site. Residual, hemodynamically significant narrowing was noted with duplex scanning in one patient after surgery, and the patient refused any further interventions. The graft thrombosed 3 weeks after its insertion. Because the patient was asymptomatic, no further therapy was necessary. The other patient's graft failed 2 months after endovascular graft placement. Kinking and narrowing of the graft at the proximal attachment site was noted at the time of open aortofemoral bypass grafting. These technical failures could have been better defined and possibly corrected with improved intraoperative completion arteriography, intravascular ultrasound evaluation, and pressure measurements. In addition, earlier interventions in patients with "failing" endovascular grafts may further improve long-term patency.

The other unique long-term complication associated with the use of endovascular grafts is the exis-

tence of endoleaks. The endoleak rate in this series was only 5%. The occurrence of such endoleaks underscores the importance of long-term follow-up examinations with duplex or CT scanning in these patients. The only patient lost temporarily to follow-up examination had such an endoleak develop that led to aneurysm rupture. If a large endoleak had been noted during the follow-up examination, the patient could have undergone treatment with another endovascular graft extending from the aorta or with an attempt at open repair if medically feasible. Major endoleaks need to be corrected because they can lead to aneurysm expansion and possible rupture.[28,29] In retrospect, our two endoleaks were the result of poor patient selection. The proximal necks in these patients were not suitable for endovascular graft repair. One neck was short (5 mm), and the other had a rim of thrombus at the proximal attachment site. An endovascular reconstruction from the healthier aorta would have been a better endovascular option to avoid the development of these endoleaks.

In conclusion, these results show that endovascular repair of isolated iliac aneurysms and pseudoaneurysms is a safe and effective technique with good midterm results in patients at moderate and high risk. These grafts are particularly beneficial in patients with medical, surgical, or anatomic contraindications for standard open surgical repair. Continuing improvements in patient selection, procedural techniques, and the design of endovascular grafts and their introducer systems will likely continue to improve the short-term and long-term results of this evolving surgical technique.

REFERENCES

1. Brunkwall J, Hauksson H, Bengtsson H, Bergqvist D, Takolander R, Bergentz S-E. Solitary aneurysms of the iliac arterial system: an estimate of their frequency of occurrence. J Vasc Surg 1989;10:381-4.
2. Lowry SF, Kraft RO. Isolated aneurysms of the iliac artery. Arch Surg 1978;113:1289-93.
3. McCready RA, Pairolero PC, Gilmore JC, Kazmier FJ, Cherry KJ Jr, Hollier LH, et al. Isolated iliac artery aneurysms. Surgery 1983;93:688-93.
4. Richardson JW, Greenfield LJ. Natural history and management of iliac aneurysms. J Vasc Surg 1988;8:165-71.
5. Nachbur BH, Inderbitzi RG, Bar W. Isolated iliac aneurysms. Eur J Vasc Surg 1991;5:375-81.
6. Sacks NPM, Huddy SPJ, Wegner T, Giddings AEB. Management of solitary iliac aneurysms. J Cardiovasc Surg 1992;33:679-83.
7. Krupski WC, Selzman CH, Floridia R, Strecker PK, Nehler MR, Whitehill TA. Contemporary management of isolated aneurysms. J Vasc Surg 1998;28:1-13.
8. Szilagyi DE, Smith RF, Elliot JP, Hageman JH, Dall'Olma CA. Anastomotic aneurysms after vascular reconstruction: problems of incidence, aetiology, and treatment. Surgery 1975;78:800-16.
9. Mikati A, Marache P, Watel A, Warembourg H, Roux JP, Noblet D, et al. End-to-side aortoprosthetic anastomoses: long-term computed tomography assessment. Ann Vasc Surg 1990;4:584-91.
10. Van der Akker PJ, Brand R, van Schlifgaarde R, van Bockel JH, Terpstra JL. False aneurysms after prosthetic reconstruction for aortoiliac obstructive disease. Ann Surg 1989;210: 658-66.
11. Treiman GS, Weaver FA, Cossman DV, Foran RF, Cohen JL, Levin PM, et al. Anastomotic false aneurysms of the abdominal aorta and iliac arteries. J Vasc Surg 1988;8:268-73.
12. Edwards JM, Teefey SA, Zierler RE, Kohler TR. Intraabdominal paranastomotic pseudoaneurysms after aortic bypass grafting. J Vasc Surg 1992;15:344-53.
13. Reuter SR, Carson SN. Thrombosis of a common iliac artery aneurysm by selective embolization and extraanatomic bypass. AJR Am J Roentgenol 1980;134:1248-50.
14. Vorwerk D, Gunther RW, Wendt G, Schurmann K. Ulcerated plaques and focal aneurysms of iliac arteries: treatment with noncovered, self-expanding stents. AJR Am J Roentgenol 1994;162:1421-4.
15. Deb B, Benjamin M, Comerota AJ. Delayed rupture of an internal iliac artery aneurysm following proximal ligation for abdominal aortic aneurysm repair. Ann Vasc Surg 1992; 6:537-40.
16. Kwaan JHM, Dahl RK. Fatal rupture after successful surgical thrombosis of an abdominal aortic aneurysm. Surgery 1984; 95:235-7.
17. Schanzer H, Papa MC, Miller CM. Rupture of surgically thombosed abdominal aortic aneurysm. J Vasc Surg 1985; 2:278-80.
18. Cho SI, Johnson WC, Bush HL Jr, Widrich WC, Huse JB, Nebseth DC. Lethal complications associated with nonresective treatment of abdominal aortic aneurysms. Arch Surg 1982;117:1214-7.
19. Marin ML, Veith FJ, Lyon RT, Cynamon J, Sanchez LA. Transfemoral endovascular repair of iliac artery aneurysms. Am J Surg 1995:170:179-82.
20. Marin ML, Veith FJ, Cynamon J, Sanchez LA, Lyon RT, Levine BA, et al. Initial experience with transluminally placed endovascular grafts for the treatment of complex vascular lesions. Ann Surg 1995;222:449-69.
21. Yuan JG, Marin ML, Veith FJ, Ohki T, Sanchez LA, Suggs WD, et al. Endovascular grafts for noninfected aortoiliac anastomotic aneurysms. J Vasc Surg 1997;26:210-21.
22. Razavi MK, Dake MD, Semba CP, Nyman URO, Lidell RP. Percutaneous endoluminal placement of stent-grafts for the treatment of isolated iliac artery aneurysms. Radiology 1995;197:801-4.
23. Johnston KW, Rutherford RB, Tilson MD, et al. Suggested standards for reporting on arterial aneurysms. J Vasc Surg 1991;13:452-8.
24. Dorros G, Cohn JM, Jaff MR. Percutaneous endovascular stent-graft repair of iliac artery aneurysms. J Endovasc Surg 1997;4:370-5.
25. Ohki T, Marin ML, Veith FJ, Lyon RT, Sanchez LA, Suggs WD, et al. Endovascular aortounifemoral grafts and femorofemoral bypass for bilateral limb-threatening ischemia. J Vasc Surg 1996;24:984-97.
26. Sanchez LA, Veith FJ, Ohki T, Marin ML, Lyon RT, Suggs

WD, et al. Early experience with the Corvita endoluminal graft for the treatment of arterial injuries. Ann Vasc Surg 1999;13:151-7.
27. Rutherford RB, Flanigan DP, Gupta SK, Johnston KW, Karmody A, Whittemore AD, et al. Suggested standards for reports dealing with lower extremity ischemia. J Vasc Surg 1986;4:80-94.
28. White GH, Yu W, May J, Chau Four X, Stephen M. Endoleak as a complication of emdoluminal grafting of abdominal aortic aneurysms: classification, incidence, diagnosis, and outcome. J Endovasc Surg 1997;4:152-68.
29. Wain RA, Marin ML, Ohki T, Sanchez LA, Lyon RT, Rozenblit A, et al. Endoleaks after endovascular graft treatment of aortic aneurysms: classification, risk factors, and outcome. J Vasc Surg 1998;27:69-80.

Submitted Sep 23, 1998; accepted May 12, 1999.

DISCUSSION

Dr Frank Pomposelli (Boston, Mass). The rational for this approach is simple: the use and close evaluation of new less invasive techniques to limit the morbidity and mortality associated with conventional surgical procedures while maintaining similar short-term and long-term success rates. The approach we describe has not been proven to be better than conventional retroperitoneal techniques but, in selected patients with appropriate anatomy who are at higher risk for perioperative comlications, may be a good alternative to standard surgical techniques. The case I showed, in fact, had a small abdominal aortic aneurysm in addition to the iliac aneurysm. A bifurcated aortic graft would have been the best operative alternative for this patient, but he was not considered to be a good surgical candiate. The aorta was only 4 cm in diameter, and the 9-cm iliac aneurysm was the life-threatening condition that needed to be addressed in this elderly, debilitated patient.

The role of endovascular grafting in the treatment of arterial aneurysms is evolving. Clearly, it is not a technique that will be applicable to all patients. At this time, the success of an endovascular repair is highly dependent on the anatomy of the aneurysm being treated. If the anatomy is favorable, high-risk and low-risk patients may benefit from this type of reconstruction, but the long-term results are still unknown.

We need to balance the natural history of the disease in a given patient and the expected results and associated complications of the treatment techniques we consider to decide which is the best procedure for specific patients. Endovascular grafts are not, at this time, the best option for the treatment of iliac artery aneurysms in all patients. Nevertheless, their role in the treatment of selected patients with good anatomy and significant risks of perioperative complications is rapidly increasing on the basis of the published short-term and mid-term results.

Dr Luis A. Sanchez. Correct. I think that the main issue you have to decide is what is the risk to the patient, and, obviously, a patient with that kind of anatomy, like the one that I discussed, in fact had a 4-cm aorta. The patient was elderly and was referred to us because of his medical contraindications. That was a 9-cm iliac aneurysm. We did not think the aorta was a problem, when he was 80, 81 years old. Yes, it could have grown. Yes, a better reconstruction would have been an aortabiiliac or aortobifemoral. I cannot disagree with that.

I think it is really going to come down to be a balance of whether the patient has a relatively simple anatomy, straightforward anatomy, if you are going to have a good result with a relatively high medical risk. Because that graft was perfectly straight, I did not think it was going to have a significant problem in the long-term period. We only know about 3 to 4 years of follow-up examination, although we have years of follow-up examinations with aortobiiliac grafts. Obviously, those are better long-term reconstructions. There is no question about that.

But we have to balance some of the risks for these patients, just as the authors were saying in the previous presentation. What really becomes an economic and other problem for these patients is the perioperative complications that affect the rest of their lives.

So, I think it is going to come down to be a real balance. This graft may not be the best option, but, for first generation grafting, I think the results were pretty good. And I think patient selection is really going to be the most important part of using this device or any other type of reconstruction you do.

Dr K. Craig Kent (New York, NY). No, I do not think so. You have to look at the expected long-term survival of the patient and the short-term and long-term complications associated with the planned procedure. The best long-term reconstruction is an aortobifemoral or aortobiiliac bypass if it is safe for the patient. In the case of many patients, medical or surgical factors that increase the potential complications of the procedure and decreased its durability have to be considered in choosing the best treatment alternative. The total complication rate in this series was just over 20%, but most of these complications were corrected intraoperatively or were local wound complications. There were no cardiac, cerebrovascular, pulmonary, or renal complications that often lead to long-term cost and disability when they occur after conventional therapy. Most major complications and failures in this series were associated with technical errors or poor patient selection. If the results continue to improve in the short

and long term, this technique may prove to be cost effective in the future for at least a selected group of patients.

Dr Sanchez. No, I do not think so. You have to look at what the long-term life expectancy of that patient is. The best reconstruction they are going to have is going to be an aortobifemoral or aortobiiliac reconstruction if it is safe for that patient. And that is, in fact, what I discussed with them. I think that would be the best option for them. And then you have to start taking some of the other factors into account. The other complication rate in the series, as I said, was 20%, but if you look at the complications themselves, there were no myocardial infarctions, there were no strokes, and no patient went into dialysis. You did not have any of the major complications that lead to long-term cost and long-term disability to these patients. A groin hematoma, in fact, and compression, some complications, but those are intraoperative or intraprocedural things that can be fixed if you are careful with the procedures. Obviously, we had a patient whose aneurysm ruptured, and that was the crucial part of all these repairs. These patients need to be followed more closely.

This is a first generation device, and, as I mentioned, patient selection is really the most important part. That patient should not have been selected for that particular reconstruction, if he was considered still to be at high risk. If he was a good risk, he should have undergone a standard repair because his neck was not a good one.

Dr Glenn LaMuraglia (Boston, Mass). In fact, the group included eight patients with pseudoaneurysms, five of which were anastomotic pseudoaneurysms. The other three were external iliac artery pseudoaneurysms in patients who had undergone previous transplant nephrectomies or other arterial procedures.

I agree with you that this technique may be particularly useful for the treatment of patients with anastomotic pseudoaneurysms after conventional aortoiliac reconstructions. In these cases, you have the limb of a graft in which to secure the endovascular graft proximally. It is likely to provide a very good proximal seal and a good long-term result. In addition, these patients would require aortoiliac reoperations that are associated with higher morbidity and mortality rates in this aging patient population.

Dr Sanchez. In fact, those three patients had undergone previous transplant nephrectomies and had pseudoaneurysms develop at the old buttons. They had undergone two retroperitoneal procedures, and they had localized pseudoaneurysms where they had the old closures, where their kidney had been resected.

None of the those cases were anastomotic pseudoaneurysms, but we do have a number of those patients. And I agree with you, for those patients in particular, it is a good reconstruction. A lot of these patients have undergone an aortobiiliac graft, had an anastomotic lesion develop, an anastomotic pseudoaneurysm. You have a proximal graft to seat an endovascular graft within, which gives you a very good seal. And you should not have any long-term problems. Those reoperative patients, as you were saying, are usually much older since they had their aneurysm fixed, 5, 10, 15 years before. But none of those patients are included in this series.

Dr David Brewster (Boston, Mass). Sure. In our experience, we have observed a 10% to 15% incidence rate of buttock claudication. The symptoms resolve in most patients within a few months but can be quite debilitating in active patients. This is one of the potential complications that have to be considered during patient selection. A good-risk, active patient who would require hypogastric occlusion for the endovascular treatment of aortoiliac aneurysms will be best served by a conventional surgical repair.

Buttock claudication is more common than the potential problem of colonic ischemia. We have only observed an occasional case of colonic ischemia in patients treated with endovascular grafts after occlusion of one or both hypogastric arteries. In many of these cases, there are associated factors (like hypotension and diffuse embolization) that are more likely the cause of the ischemic symptoms.

Dr Sanchez. Sure. In fact that is exactly true. We have, in our experience, somewhere around 10% to 15% buttock claudication incidence rate. Most of these cases resolve within a month to 2 months, and their symptoms improve. But that is where I think patient selection really comes into play.

I do not see doing this kind of a reconstruction on a young, very active patient. I think those patients should undergo surgical repair. And that has to be kept in mind.

I think that is more of a problem than the potential problem of colonic ischemia. If you have a patent hypogastric artery on the other side and collateral from the superior mesenteric artery, I do not think colonic ischemia really has been a problem, even though it is a real theoretic problem, but buttock claudication has been.

Thank you.